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ABSTRACT

This booklet tells how to set up an Energy Conservation Program in individual school districts. It discusses: (1) appointing an energy conservation manager; (2) keeping energy consumption records; and (3) assessing the energy saving potential of each school; and it outlines (4) some of the steps that can be taken to cut down energy waste. Estimates vary, but most schools in British Columbia could reasonably expect to make at least a 20% reduction in energy consumption simply by improving their operating procedures (tightening their heat and lighting time schedules, maintenance practices, etc.) and by making minor alterations to their equipment. Sample copies of the energy consumption record sheets for electrical, oil/gas, and total energy consumption are included. (Author/TM)

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SE 026 502

ENERGY CONSERVATION FOR SCHOOLS

ENERGY CONSERVATION FOR SCHOOLS

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Province of British Columbia

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Cover theme . . .
steps to energy conservation
for schools, whatever the weather
day and night.

Editorial Consultant: Richard Abercrombie

REASONS FOR CONSERVING ENERGY

One doesn't have to look very far to find the answer to the question, why conserve energy? Saving energy makes economic sense. Oil and gas resources are diminishing while their cost is correspondingly increasing. Saving energy, then means saving money, a significant amount of money. Conserving energy makes sense in terms of protecting ourselves for the future. Conserving the energy we do have will buy time to find new oil and gas reserves and to seek sources of energy other than fossil fuels. Saving energy also makes moral sense in that it is better to use something prudently than to waste it.

In a recent report the B.C. Energy Commission outlines the government's approach in the past to meeting energy needs and states why it should be changed:

"Traditionally, the focus of government energy policy has been on securing additional energy supplies to fulfill burgeoning requirements for all energy sources. During a period of declining real energy costs, this policy made sense. But now the cost of securing such supplies is so enormous that encouragement of efficient use of existing supplies is of paramount importance, both in economic terms and in terms of conserving energy resources for the future.

The Commission concluded that energy conservation should be given a priority equal to that accorded to stimulating additional energy supplies."

That drip of hot water adds up. At one drop per second, a dripping hot water tap can waste about 175 gallons of hot water each month. If every school in British Columbia had four dripping taps, it would take 100,000 gallons of oil each year to heat the wasted water.

Seeing a need for energy conservation, requires a change in the way we think about energy. No longer can we afford to think of oil, natural gas, electricity and coal as abundant, inexpensive resources that can be taken for granted. Most of our current energy resources are limited; all our energy is valuable and should be used efficiently.

The energy conservation program outlined in this booklet will reduce energy consumption in most schools in British Columbia. A 20% reduction is thought possible. It must be stressed that the 20% is not an exaggeration; this figure can be attained and at a cost that would pay for itself in one to two years.

Such reductions have been achieved in school districts in other areas. For example, a recent Ontario government report stated that:

"When the annual energy consumption of a group of very similar schools — all constructed in the same year in Toronto — was compared, it was found that some of the schools were consuming more than twice as much energy as others. A thorough check of the "problem" schools revealed maladjustment of controls, jammed outside-air dampers, and other similar maintenance problems."

In one American state an energy conscious maintenance and operations program resulted in a 15% decrease in total school energy consumption. Since only half of the schools participated, it was projected that a 20 to 30% savings was possible.

The point is that with a carefully managed energy program significant amounts of energy and money can be saved in schools.

A few degrees can make big savings. For example, if you lower your temperature 3°C (5.5°F) on a 24-hour basis, your heating fuel consumption would be reduced by about 10 per cent.

SUMMARY OF THE STEPS TO SET UP A CONSERVATION PROGRAM

These four steps are recommended to set up an energy conservation program. All of the steps summarized here are presented in greater detail in the following pages.

1. **Appoint an Energy Conservation Manager**
   School boards should set an official district policy of energy conservation and appoint an Energy Conservation Manager. Depending on the district's size and staff, the conservation manager could be an official familiar with school operations or an interested person with the enthusiasm and time necessary to organize an effective program. The role of the manager and of the others he finds to work with him will be to find out how much energy each school is using and to recommend to the board the conservation measures that should be taken in different schools.

2. **Establish Energy Consumption Records in each school**
   Energy Consumption Records (sample recording sheets are provided) determine the exact amount of energy per year each school is using.
   Filling out the record sheets, a school arrives at an energy consumption figure. Since this figure takes into account floor area and outside temperature, it provides a basis for comparing the energy consumption of different schools.
   It is recommended that record sheets be filled out for the past year (the necessary figures should be available) so that

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schools don't have to wait a full year for their energy consumption data.

The Ministry of Education would like to have each school's record sheets on file along with any other conservation ideas or accounts of conservation measures taken. Please send this material to: Ministry of Education, Facility Services Division, 835 Humboldt, Victoria, British Columbia. V8V 2Z7.

3. **Compare Energy Consumption Figures**

Collect the energy record sheets from each school and compare the consumption figures. Being realistic, a school district probably won't be able to have a conservation program in every school right away. By comparing the energy figures the energy manager can see which schools are proportionately using the most energy and can concentrate his efforts on them. He may also want to compare the energy consumption of his schools with schools in other districts in British Columbia or in other parts of the country.

In succeeding years the record sheets will also provide ongoing data to monitor the success of the energy conservation program.

An energy consumption target range is given in Table I as a standard against which a school's energy use can be compared. This range, considered attainable without major expense by most schools in British Columbia,will give an idea of a school's energy saving potential. How do your schools measure up to these energy consumption targets?

4. **Conduct Energy Surveys to determine ways of saving energy**

An energy survey is conducted to find out where energy is being wasted and what can be done about it. Cost estimates of energy improvements should be included in the survey. The survey could be conducted by experienced technical personnel from school board staff, from trades, or ideally from consulting engineering firms who do energy efficiency studies. A list is given of items that the survey should include. Some items suggest changes in operating and maintenance procedures that will cost little or no money; other items require changes that are more expensive. The list is mainly confined to conservation measures that can be paid for from money saved in one to two years.

The energy manager may wish to wait until individual school consumption figures are compiled before carrying out energy surveys. It should be mentioned, however, that surveys will locate significant energy saving areas in almost every school. It might also be added that prompt attention to energy surveys and their recommendations will show immediate improvements in the first year's energy consumption figures.

ENERGY CONSERVATION MANAGER AND COMMITTEE

The energy manager can be a teacher, an administrator, a school board member, a maintenance person, or can even be someone from outside the school system. The important thing is that he wants to do something about saving energy and is willing to spend the time to establish an energy conservation program. The energy manager should look for others interested in or knowledgeable about the subject to work with him on a committee.

The board should notify schools about the Energy Conservation Program and request their cooperation with the program manager.

The energy manager should periodically report to the board presenting data summaries and recommendations for board officials to make decisions on.

Some sources of information that may be useful to the energy manager and his committee are:

- B.C. Energy Commission
- B.C. Hydro
- local utilities office
- technical experts in the community
- publications

1. *100 Ways to Save Energy and Money in the Home*
   (Tips on how you can stretch Canada's energy resources and put money in your pocket.)
   Office of Energy Conservation
   Energy, Mines and Resources Canada
   Available free from: 100 Ways, Box 3500,
   Station C, Ottawa,
   Ontario, K1Y 4G1
   (or B.C. Hydro)

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2. *Keeping the Heat In*
(How to re-insulate your home to save energy and money.)
Office of Energy Conservation
Energy, Mines and Resources Canada
Available free from:

Keeping the Heat In
P.Q. Box 900
Westmount Postal Station
Montreal, Quebec H3Z 2V1
(or B.C. Hydro)

3. *Energy Sourcebook for Educational Facilities*
(A technical manual for school energy conservation.)
Available for U.S. $27.50 from:

Council of Educational Facilities
Planners, International
29 West Woodruff Avenue
Columbus, Ohio U.S.A. 43210

4. *Enersave Industrial Energy Conservation Manuals*
(Ten manuals on different aspects of energy use, including heating, cooling and lighting.)
Office of Energy Conservation
Energy, Mines and Resources Canada
Available for $5.15 including binder from:

Master Mailers
P.O. Box 9705, Terminal Ottawa
Ottawa, Ontario K1G 3Z4

ENERGY CONSUMPTION RECORDS

The energy consumption record sheets provided at the back of this booklet have been set up to conform with information given on utility invoices. If difficulties arise transferring the information from the invoice to the energy sheets, contact your local utility company. There are three sheets: Sheet #1 records electricity consumption; Sheet #2 records oil/gas consumption; and Sheet #3 calculates total energy consumption and calculates a comparison figure for heating by taking into account the outside temperature factor.

Sheet 1. Electrical Energy Consumption

Essentially, this sheet takes the amount of kilowatt hours (KWH) of electricity a school used and divides it by the school's area. Thus a figure is obtained for the average amount of KWH of electricity used for one square meter of space.

To complete Sheet #1 the gross floor area must be recorded. Most school floor spaces will be stated in square feet and will have to be changed to square meters. One square foot equals .093 square meters.

Most schools that are heated electrically do not have separate meters for heating, and for lighting and electrical appliances, and so Sheet #1 would represent a combined total of electricity for heating, lighting and electrical appliances. In the case, however, that the heating electricity is metered separately, two copies of Sheet #1 should be recorded, one for heating and one for lighting and electrical appliances.

On the next page are the columns found on Sheet #1, Electrical Energy Consumption, and some notes that may help in filling them out.

Note: This information, although important for the total cost of heating does not enter into the Unit Area Consumption figure.

Billing Date	Rate	Reading Period From	Reading Period To	Consumption KWH	KW Demand Reg	KW Demand Billed	Power Factor	Cost	Unit Area Consumption KWH/M²

Note that the sheet requires readings over one complete year (12 months).

In this column take the number of KWH from the "Consumption KWH" column and divide it by the gross floor area (M^2) of the school.

Sheet 2. Oil/Gas Energy Consumption

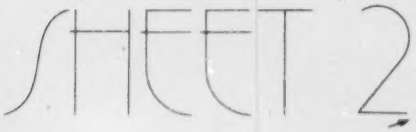
This sheet takes the amount of oil and/or gas a school uses, converts it to kilowatt hours, and divides it by the school area, arriving at a figure that gives the average amount of oil or gas used for every square meter of space.

The gross floor area can be taken from Sheet #1.

In the case that oil use is not metered, start and end the year with a full tank.

If a school is electrically heated and does not use oil or gas, Sheet #2 does not need to be filled out.

Below are the columns found on Sheet #2, Oil/Gas Energy Consumption, and some notes that may help in filling them out.



If oil consumption is not metered and billed monthly record from full tank to full tank.

Billing Date	Rate & Fuel	Reading Period From	Reading Period To	Total Oil Consumption Gals	Total Oil Consumption KWH	Total Gas Consumption Therms	Total Gas Consumption KWH	Total Cost	Unit Area Consumption KWH/M²

Oil consumption is measured in gallons. One gallon of #2 oil = 48.94 KWH, and so to convert gallons to KWH, multiply the gallons by 48.94.

Gas Consumption is measured in "therms". One therm = 29.31 KWH. To convert therms to KWH, multiply the therms by 29.31.

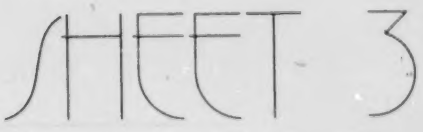
In this column take the amount of KWH of oil and/or gas and divide it by the gross floor area.

Sheet 3. Total Energy Consumption

Sheet #3 collects the information from Sheets #1 and #2 and accounts for the outside temperature factor. The amount of heat is divided by the degree days (defined below) so that the heating consumption of a school can be accurately compared from one winter to another, and so that heating consumption of schools in different climates can also be compared.

The number of degree days per calendar day is determined by subtracting the average daily temperature from 18°C. For example, if the average temperature for a day is 8°C, the number of degree days is 10. Note that any day with an average temperature over 18°C is considered to have 0 degree days. Victoria and Vancouver have approximately 3000 Celsius degree days per year while Prince George has approximately 5300 Celsius degree days. Don't worry, degree days won't have to be calculated; they are available from Environment Canada's Atmospheric Environment Service on a monthly and yearly basis.

Below are the columns found on Sheet #3, Total Energy Consumption, and some notes that may help in filling them out.



These columns are filled in from Sheet #1 and #2.

Note that "degree days" (DD) apply to heating. However, if heating and lighting of electrically heated schools are metered together, the degree days will have to apply to lighting as well.

Reading Period		Unit Area Energy Consumption				Degree Day Celcius	Degree Day Energy Consumption		
From	To	Heating Elect KWH/M²	Elect KWH/M²	Oil/Gas KWH/M²	Total KWH/M²		Heating Oil/Gas KWH/M² DD	Heating Elect KWH/M² DD	Total Elect KWH/M² DD

Fill in if electrical heating is metered separately.

Total the KWH/M² for heating, lighting & electric appliances.

Degree days available from offices of Atmospheric Environment Service, Environment Canada.

If school is heated by oil or gas take the oil/gas KWH/M² figure and divide it by the degree days.

If electric heating is metered separately, take the KWH/M² for heating and divide it by the degree days.

If electricity meter is combined for heating and lighting, take the total KWH/M² and divide it by the degree days.

ENERGY CONSUMPTION TARGETS

Energy consumption in schools varies with hours of use, insulation levels, window area, lighting levels, quality of heating and ventilating systems and occupants energy awareness. Energy consumption targets shown in Table I are therefore approximate. The target figures do, however, list unit area energy consumption levels which should be attainable in a large number of schools without major capital expenditures. These energy consumption targets can readily be compared with actual energy consumption figures to get an indication of probable energy saving potential.

It should be noted that electrically heated schools generally have lower energy consumption levels because they are usually much more heavily insulated. Also, virtually 100 percent of metered electrical energy is converted to heat. Electrical heating rates, however, are substantially higher than the rates for natural gas.

Notes on Using the Table

1. Compare the annual total figures from Sheet #3 with the target range figures.
2. To better see how a school's figures measure up against the target figures, it might be useful to turn the amount that is over into a percentage. For example, an elementary school that is gas heated has a Heating KWH/M²/DD/year of .044. Taking the top of the target range, the .035, as 100%, the .044 is 125% or 25% over the consumption target.
3. Since most electrically heated schools do not have a separate meter for heating, they will only be interested in the last column on the table, Total Energy KWH/M²/DD/year. Note that two target ranges are given, one for schools in a 3000-4000 DD climate and another for schools in a 4000-5000 DD climate.

ENERGY CONSUMPTION TARGETS

TABLE 1

School Type	Lighting & Misc. Elec. KWH/M²/Year	Heating KWH/M²/DDC/Yr.	Total Energy* KWH/M²/DDC/Yr.
Elementary Schools:			
1) Electrically heated			.025 - .035
2) Gas or oil heated	35 - 45	.030 - .035	
Secondary Schools:			
1) Electrically heated			.035 - .045
2) Gas or oil heated	40 - 50	.035 - .040	

Table based on following assumptions:

- Elementary school area — 2000 to 4000 M²
- Secondary school area — 5000 to 15,000 M²
- School in use two evenings per week
- School provided with forced air ventilation system, without air conditioning
- Classroom lighting connected load — 22 to 26 watts/sq.m.

R Value walls — 5 to 8
R Value roof — 7 to 10
Window — 30 to 40% wall area
single glazed up to 3500 DDC

*Electrically heated schools will normally be provided with one meter only and as a result it will be possible to compare total energy use only.

ENERGY SURVEY

The objective of an energy survey is to cut down energy consumption by finding ways of using it more efficiently. Four major areas of conservation strategy are:

1. Manage the plant so that it consumes energy only when needed and in amounts needed.
2. Eliminate waste of energy due to inadequate maintenance.
3. Reduce energy loads to a minimum, taking occupancy requirements and economic factors into account.
4. Use equipment and systems that utilize energy efficiency.

Energy surveys could identify significant energy saving improvements in most schools in British Columbia, especially in the larger ones. Experienced technical personnel either from the school board's staff or from a consulting engineering firm should conduct the survey and submit a report that includes a series of specific recommendations with cost estimates and with projected savings of kilowatt hours and dollars per year. Below is a list of conservation items that an energy survey should cover. Don't be restricted to this list, though, as it is by no means definitive. It contains areas in schools where energy can likely be conserved, but there are many other things that could also be done to save energy. Energy conservation is a broad field ranging from something as simple as turning out lights to something as sophisticated as architectural design. Much that can be done will depend on the building, its situation and climate, and of course on available funding.

Note how important maintenance staff are to an energy conservation program. Close communication between administrators and maintenance personnel is necessary to act on building survey recommendations and to carry out ongoing conservation practices. An educational program for operating staff on conservation of energy might be considered.

1. **Ventilation Systems**

Most schools have forced air ventilation systems which provide:

- some cooling in mild weather to offset heat from lights, people, sun, etc.;
- sufficient fresh air for odour control; and
- make-up air to balance exhaust air systems.

Many ventilation systems are set to provide a minimum fresh air supply in the range of 7 to 9 dm^3/s (decimeters cubed per

second) per pupil. Expressed in cubic feet per minute this would be 15 to 20 CFM. Tests have now established that fresh air supply in the range of 2.4 to 3.5 dm^3/s (5 to 7.5 CFM) per pupil is acceptable in most situations. Lowering the fresh air supply rate will reduce the energy required to preheat cold, outside air.

At the same time the fresh air supply rate is lowered, the capacity and operation of exhaust air systems should be assessed, checked and modified to ensure that the diversified exhaust air flow rate is less than the minimum outside air ventilation rate. Exhaust fan systems should shut off automatically wherever practical.

Ventilation systems should be on only while students are in class. If the ventilation systems are separate from the heating system, they should be shut off automatically after school hours. If the ventilation system is combined with the heating system, the outside air dampers and relief air dampers should automatically close after school hours and remain closed until after the school is reoccupied.

Classroom unit ventilators with automatic fresh air control should also be checked. These units may be wasting energy by bringing in too large a percentage of cold, outside air and by heating this cold air twenty-four hours a day. In such cases modifications to the automatic controls would be required, and possibly an overhaul of sticking or sluggish automatic dampers.

Generally, these modifications of ventilation systems can be paid for from the first year's fuel savings.

2. **Hours of Operation — Night Set Back**

   School heating systems should have a night set back control. Thought should be given to the earliest time after classes the temperature can be lowered, keeping in mind that it will take awhile for the temperature to go down after it has been turned back. In mild areas the temperature can be set back to 7°C (45°F), providing the heating system has the capacity to bring the school back to normal temperature before school starts. In addition, in mild weather the heating plant can be completely shut down over night and on weekends.

3. **Automatic Controls**

   All automatic controls in the school should be checked to ensure they are working properly, and corrections made where required. Room thermostats should be of the type not readily adjustable and have a setting of not more than 21°C (70°F).

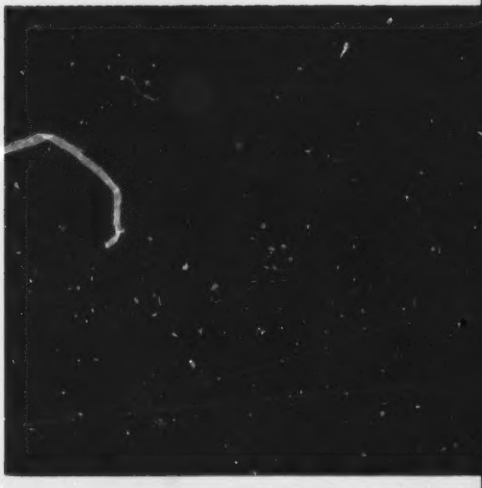
Windows should be kept closed in cold weather. The controls of any overheated rooms that need to have windows opened should be regulated.

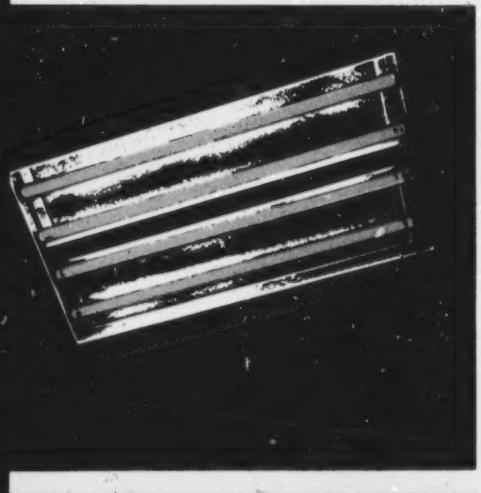
4. **Boiler Plant**
   The condition and efficiency of the existing plant should be assessed and improved where practical. Following this, regular checks of stack temperature and CO_2 should be carried out and required maintenance performed to keep the plant operating at maximum efficiency.

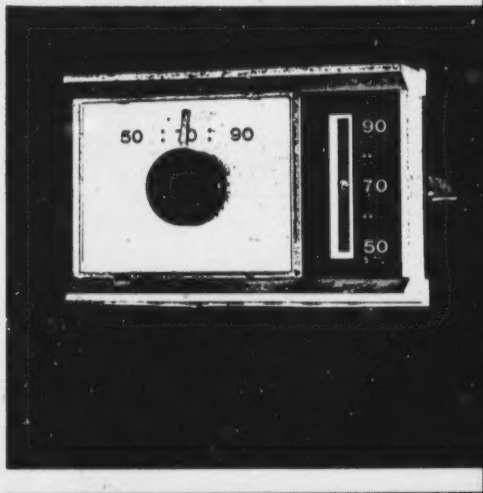
5. **Domestic Hot Water System**
   It is possible that lower flow rate shower heads could be installed. Automatic water temperature control and timers should also be considered to both lower the temperature and limit the on-time of the hot water system. As illustrated earlier it is also worthwhile to fix all dripping taps.

6. **Building Tightness**
   Buildings should be checked for air leakage around doors and windows, and weatherstripping installed where required. In addition, the longer term advisability of adding insulation, double glazing, etc., should be assessed.

7. **Electrical Power Consumption**
   It is possible that necessary lighting levels can be achieved with lower wattage. The intensity of corridor, lobby and storeroom lighting should be reviewed, as substantial reductions in light level may be acceptable.
   Also, rows of lights adjacent to windows could be separately switched and turned off during day classes.
   One of the best ways of saving electricity is to turn off the lights when a room is not in use. Teachers should turn lights out when they leave their room at night, and maintenance staff should light only the rooms they are working in.
   The cost of electricity in most schools is based on a charge for being ready at any time to supply the peak load of kilowatts required (the demand charge) plus a charge for kilowatt hours actually consumed (the energy charge). Normally the demand charge will represent about 65 per cent of the total energy cost. Thus anything that can be done to reduce the peak load will make substantial cost savings. Reducing the lighting levels in non-essential areas and turning lights out in unused classrooms will decrease the peak load. Staggered scheduling for use of kilns, welding machines and other electrical machinery, will also cut down peak load requirements.



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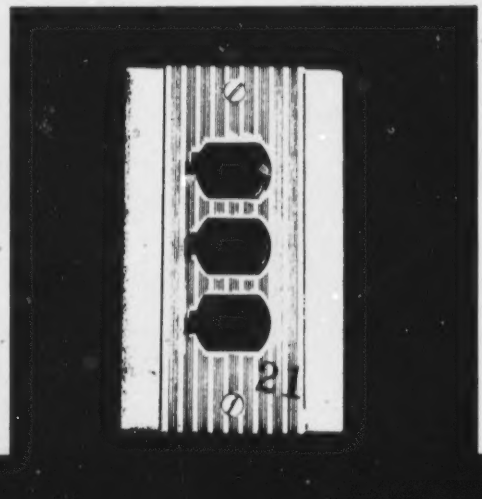
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8. **Major Retrofit**

The building survey report should include an assessment of major retrofitting for further reducing energy consumption. This assessment would involve such items as major changes to heating and ventilating systems, additional thermal insulation and heat recovery. These changes would require a longer pay back period than most of the other conservation steps mentioned above.

OTHER CONSERVATION MEASURES

Following is a brief list of additional conservation measures which should be considered:

1. Establish a preventative maintenance program to regularly service and inspect equipment.
2. As part of the preventative maintenance program, clean lighting fixtures and, where possible, replace fluorescent tubes with energy saving tubes.
3. Schedule control and switching off of exterior lighting.
4. Revise electrical circuits to allow partial switching of electrical loads.
5. Ensure that operating personnel are familiar with equipment, installations and distribution systems.
6. Check heating radiation surfaces for obstructions.
7. Add automatic controls wherever possible to allow the most economical operation of equipment.
8. Examine air distribution ducts for leaks, deterioration, separation of insulation, heat pick-up from pipes; and assess insulation improvements.

STAFF AND STUDENT ASSISTANCE

Most of the conservation improvements recommended in this booklet depend on administrators and technical and maintenance personnel, and do not really involve teachers or students. Some of the changes, however, will directly affect teachers and students and will need their cooperation. For example, if a night set back of 4:30 p.m. is desired on nights that a school is not in use, some teachers might be inconvenienced and their understanding would be needed. Another conservation measure requiring support would be experimenting with a 20°C (68°F) temperature. If teachers and students were unsympathetic, their complaints would make lowering the temperature very difficult. It is important for the success of a conservation program that the energy manager communicate to teachers and students what he wishes to accomplish and to try to get their interest and support. Also, a quick response should be made to any unforeseen problems that conservation measures may create for those using the school.

Teachers and students can directly assist a conservation program as well as give moral support. At a staff meeting the energy manager could ask teachers to point out areas where they think energy is being wasted. He will probably hear about lights in stock rooms that are needlessly left on or windows that have to be opened because some rooms are overheated, etc. — all things that individuals can do something about. Some conservation measures that teachers could take are:

- turn the lights off in unused classrooms, and turn out the classroom lights when they leave at night.
- turn off exhaust fans, shop equipment, etc. when not needed or not in use.
- experiment with shutting off lighting adjacent to windows during day classes.

SAMPLE ENERGY CONSUMPTION RECORD SHEETS

SHEET 1

ELECTRICAL ENERGY CONSUMPTION

SCHOOL NAME _____ ADDRESS _____

SCHOOL DISTRICT _____ GROSS FLOOR AREA _____ M²

HEATING FUEL: GAS ☐ OIL ☐ ELEC. ☐

FORCED AIR VENTILATION: YES ☐ NO ☐

AIR CONDITIONING: YES ☐ NO ☐ PARTIAL ☐

Billing Date	Rate	Reading Period		Consumption KWH	KW Demand		Power Factor	Cost	Unit Area Consumption KWH/M²
		From	To		Reg.	Billed			
ANNUAL TOTAL									

B.C. Energy Commission

Note: 1 Sq. Ft. = .093 sq. meters.

SHEET 2

OIL/GAS ENERGY CONSUMPTION

SCHOOL NAME _____ ADDRESS _____

SCHOOL DISTRICT _____ GROSS FLOOR AREA _____ M²

HEATING FUEL: OIL ☐ GAS ☐ ELEC. ☐

FORCED AIR VENTILATION: YES ☐ NO ☐

AIR CONDITIONING: YES ☐ NO ☐ PARTIAL ☐

Billing Date	Rate & Fuel	Reading Period		Total Oil Consumption		Total Gas Consumption		Total Cost	Unit Area Consumption KWH/M²
		From	To	Gals.	KWH	Therms	KWH		
ANNUAL TOTAL									

B.C. Energy Commission

Note: One therm = 29.31 KWH; One gallon #2 Oil = 48.94 KWH
One gallon Propane = 34.28 KWH

SHEET 3

TOTAL ENERGY CONSUMPTION

SCHOOL NAME _____ ADDRESS _____

SCHOOL DISTRICT _____ GROSS FLOOR AREA _____ M²

HEATING FUEL: OIL ☐ GAS ☐ ELEC. ☐

FORCED AIR VENTILATION: YES ☐ NO ☐

AIR CONDITIONING: YES ☐ NO ☐ PARTIAL ☐

Reading Period		Unit Area Energy Consumption				Degree Day Celcius	Degree Day Energy Consumption		
From	To	Heating Elect. KWH/M²	Elect. KWH/M²	Oil/Gas KWH/M²	Total KWH/M²		Heating Oil/Gas KWH/M²/DD	Heating Elect. KWH/M²/DD	Total Elect.* KWH/M²/DD
ANNUAL TOTAL									

B.C. Energy Commission

*Complete only if school electrically heated with combined meter.